1. Title:

Encouraging the use of buckwheat cover crops for weed control by reducing the risk of volunteer seedlings.

2. Project Leader(s):

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3. Cooperator(s):

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4. Abstract:

A buckwheat cover crop is known to be an effective weed control tool, but it is underutilized. An project to reestablish its use in the modern context is ongoing. One necessary addition is better guidance on preventing and managing buckwheat volunteers. This work has identified sources of volunteers and timing to minimize those sources. Accurate information on volunteer management will greatly facilitate adoption of a practice that can reduce weed pressure in vegetable systems and thereby reduce herbicide application by one spray while providing better weed control and less soil degradation.

Our findings have the practical conclusions that:

- Volunteers can be avoided by mowing or incorporating the crop 35 to 40 d after seeding.
- Seed that is planted too deep to emerge initially is *not* a source of volunteer seedlings.
- A cover crop can be successfully established by drilling, or by the cheaper method of broadcast seeding. In either case, seeds should be covered but as shallow as possible.

5. Background and justification:

Cultural control of weeds is a recurring theme in the IPM priorities for vegetables, alfalfa/grass and field crops. The specified goals include pesticide reduction, improved control with existing herbicides, soil quality improvement, and controls suitable for organic production. Cover crops are specifically mentioned as one cultural control needing work. This projectl is specifically targeted to those priorities.

A Cornell group (Björkman with weed scientists Russ Hahn and Robin Bellinder) is currently developing extension guidelines for using buckwheat as a cover crop. That effort emphasizes collecting information from farmers about their successful implementation.

We surveyed vegetable and strawberry producers regarding the information they needed in order to feel confident that they would be successful using a buckwheat cover crop. A common answer was how to manage volunteers.

This project enables implementation of a weed control technique that is currently used far less than its potential. The project further supports IPM goals because buckwheat cover crops improve soil quality over current practices and are readily employed in organic production.

6. Objectives:

1. Identify the latest stage of growth at which buckwheat can be killed by mowing or by incorporation without producing volunteer seedlings.
2. Identify the effect of seeding technique on the number of latent seeds.
3. Project evaluation**:** In the 2007 season, 40 growers will test the draft recommendations.

7. Procedures:

1. Buckwheat has considerable capacity to mature seed even after the plant is cut. We will determined how long after flowering one can wait until a cut plant will make a significant amount of viable seed. Furthermore, we determined whether the major sources of new viable seed is from flowering at the lowest node of cut plants, from pieces left by the flail mower, or from plants that escape mowing because they were laid down by the tractor wheels. Plants were killed at four time points using two methods, with four replications of each. Plants will be killed at 30, 35, 40 and 45 days after sowing. This range covers development from first anthesis through appearance of the first viable seed. Plants were killed either by flail mowing or by mowing followed by disk incorporation. Control plots were cut at 25 days with a sickle bar mower and the plant material removed. Volunteer seedlings were counted five and ten days after killing.

2. Volunteers might arise from seed that fails to germinate in the first planting. These seed typically germinate when the ground is worked for the next crop. We need to know how to assure complete germination in the first sowing to minimize this seed bank. Four planting methods were used at the research farm in a randomized strip trial with four replications. They were: drilled (deep [2 1/2”] or shallow [3/4”]) after disking) and broadcast followed by incorporation deep (heavy disk) or shallow (smooth drag harrow). One month after seeding—well before any seeds form—the buckwheat was mowed then harrowed lightly. We measured emergence of volunteers after one and two weeks.
We also conducted a greenhouse study on the fate of buckwheat seed at different depths, to assess the depth at which there is potential to retain viable ungerminated seed.

3. Project evaluation. The effectiveness of the predictions from this research will be evaluated in light of grower’s experiences after the trial. In the 2007 season, 40 growers will test the draft recommendations as part of the NE-SARE project. They will be surveyed about the adequacy of the information about volunteers. Furthermore, those growers who use herbicides will be asked whether the buckwheat cover crop allowed them to skip an herbicide application, or whether they anticipate that it will when they use it in the future. The results that are borne out on cooperators farms will be part of the educational materials (written, online, and experiential) developed with major funding from NE-SARE.

8. Results and discussion:

When to kill cover crop to prevent volunteers

Figure 1. Appearance 75 days after sowing after having been mowed at

30 days	35 days	40 days	45 days
Strong regrowth	Weak regrowth	Trivial regrowth	Trivial regrowth
Mature seeds	No seeds	Few mature seeds	Mature seeds

When buckwheat was mowed just as flowering began, growth was strong, flowering continued, and enough seeds matured from these flowers to create volunteer pressure. At the other extreme, 45 day old plants had enough immature seeds that a significant number of seedlings formed from them. Mowing at 35 to 40 days resulted in no seed production.

When buckwheat was disk incorporated at the same times, by 75 days fall weed growth was significant at the 30 d incorporation, but there were no volunteers. Incorporation at 35 to 45 days resulted in few weeds. Waiting until 45 days resulted in a significant flush of fall buckwheat volunteers. Spring volunteer growth—the real problem—will be assessed in May, 2007.

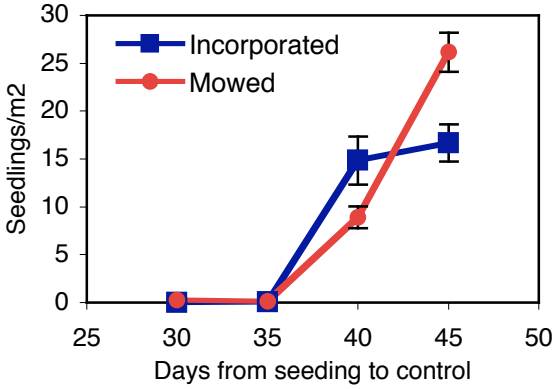

Figure 2. Volunteer seedlings in fall following control of cover crop growth.
Buckwheat was killed by mowing or incorporation at different times after seeding. Seedlings were counted 20 d later.

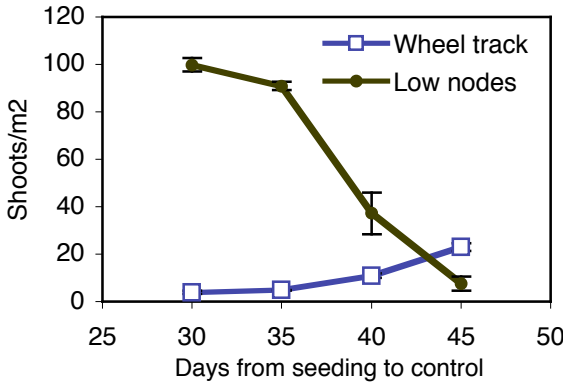

Figure 3. Regrowth of flowering shoots after mowing
Buckwheat was mowed at different times after incorporation. Flowering shoots were counted 20 d later, both from plants that were toppled in the wheel track, and remnants of those that had been mowed off.

Ideally growers should mow or incorporate between 35 to 40 days to obtain the benefits of the cover crop, while minimizing volunteers. Mowing earlier is possible if the cover crop is to be incorporated within 20 days. However, weed suppression is significantly reduced.

Identify the effect of seeding technique on the number of latent seeds.

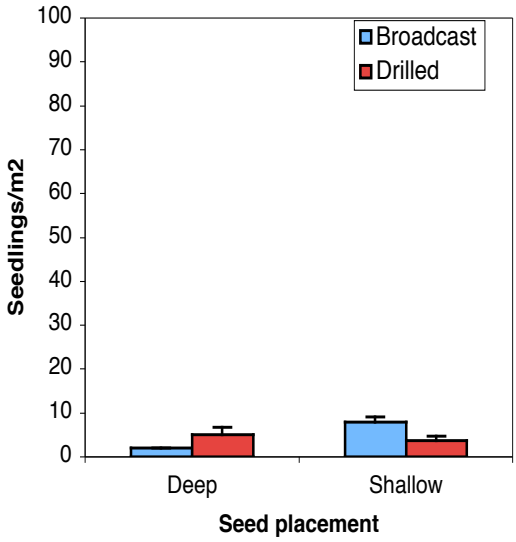

Figure 2. Buckwheat cover crop was seeded at 150 seeds per square meter, then mowed off after 30 days and lightly harrowed.

Ungerminated seeds were not a significant source of volunteers. The cover crop was seeded at 150 seeds per square meter, then mowed off after 30 days and lightly harrowed. Fewer than five buried seed germinated per square meter. We anticipated that deep seeds would remain ungerminated and be available for germination. That was not the case.

In the greenhouse we found that seeding depth affects the ability of buckwheat to suppress weeds. Buckwheat emerged in 4.3 days when sown at 1 cm, and is delayed by about 1.5 days for every inch of increasing depth. The percentage emergence also declined by 10% for every inch of depth. However the seed that did not emerge was found to be rotten or have distorted seedlings. There were no residual seeds with potential to produce volunteers.

Therefore, the least expensive planting method, broadcast seeding with incorporation, is effective and does not pose a risk of volunteers. Incorporation should leave the seeds covered but close to the surface.

What reductions in pesticide use or risk could result from this work?
Implementation of summer cover crops for weed management—for which this work is a prerequisite—is expected to reduce herbicide use through reduced weed seedbanks.
b) How many growers or acres could benefit from this work?
We anticipate that use of a buckwheat cover crop is appropriate on 5,000 acres per year if New York vegetable ground. Approximately half of the growers we have spoken with would not use the technique without better guidance to avoid buckwheat volunteers.
Thus we expect the potential audience, once the extension project is complete, to benefit at least 2,500 acres farmed by 100 farmers.

What economic and environmental values and benefits could growers reap from this work?
Soil degradation is a concern in intensively tilled vegetable production. Increased use of summer cover crops, in particular buckwheat, will reverse some of that degradation. The result will be more efficient use of fertilizers, reduced need for herbicides and crop protectants, and reduced runoff from fields during storm events.

How could this research, if used, reduce costs or improve profits for grower?
Preventing buckwheat volunteers reduces the cost of cultivating or spraying to remove them. More importantly, knowing that buckwheat volunteers will not be a problem, allows vegetable growers to use a buckwheat cover crop to reduce weed pressure and improve soil condition. Those effects increase the yield potential of fields and reduce the cost of other weed management practices.

What needs to be done to assure that this research is used?
An aggressive extension program in the context of summer cover crop use. Such a program will be conducted in 2007 with funding from NE-SARE.

What might it cost to implement your research findings?
There is no additional cost to using the recommendations produced by this project to reduce the incidence of volunteers. Attention to timing will require using management time differently, but the overall cost is the same.

What part of this project is ready for commercial use?
This projects results are ready for commercial use now.

Does part of this project need commercial-level testing before it can be fully put into place?
We will be doing commercial testing of buckwheat cover crops in 2007; the results from this project are essential for the success of that testing.

What part of this project requires more research?
It is necessary to follow up in 2007 to determine how many spring volunteer appear in the different treatments.
Growers would like to know the efficacy of buckwheat cover crops against some specific problem weeds, including nutsedge, oxalis and Canada thistle.

How has this project been publicized to growers, the public, or stakeholders?
Two field days and an in service training lecture for CCE staff in 2006 showed growers and field staff the effectiveness of the techniques. Substantial further publicity is planned for 2007.

What needs to be done in the future to maintain or improve this project's impact?
The ongoing SARE-funded project will provide implementation of the results. The project could have greater impact by having additional data on the efficacy of buckwheat cover crops on specific problem weeds such as nutsedge, oxalis and Canada thistle.

9. Project location(s):

The results of this project are generally applicable in temperate vegetable production areas worldwide. The specific outcomes are especially relevant in the Northeast, Great Lakes and Pacific Northwest.